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(54) IMPROVEMENTS RELATING TO CENTRIFUGAL SPEED GOVERNORS FOR FUEL-INJECTION INTERNAL COMBUSTION ENGINES

(72) We, ROBERT BOSCH GmbH, a German Company, of Postfach 50, 7 Stuttgart 1, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a centrifugal speed governor for fuel injection internal combustion engines.

More particularly the present invention relates to a centrifugal speed governor for fuel-injection internal combustion engines, particularly Diesel engines, having a regulating member which is displaceable by fly-weights in dependence upon the rotational speed of a drive shaft, the movements of the regulating member being transmitted by way of an intermediate lever to a fuel delivery quantity adjusting member which can adjust the delivery quantity of a fuel injection pump, the travel of the delivery quantity adjusting member in the direction of an increasing delivery quantity being limited by a stop which determines the maximum delivery quantity and which is rotatable in dependence upon the engine speed, which stop is mounted on a spindle fixed relative to the governor housing and is coupled to the regulating member and provided with a cam plate having a cam portion for determining the full load fuel delivery quantity and a cam portion for determining the excess fuel starting quantity, a follower member, connected to the fuel delivery quantity adjusting member, engaging said cam plate during delivery of the maximum fuel delivery quantity associated with each engine speed.

Centrifugal speed governors of this kind, in which the excess fuel starting quantity is controlled in dependence upon rotational speed, can be set such that the excess fuel starting quantity is shut off at an engine speed below the idling speed, i.e., the excess fuel starting quantity cannot be injected when the engine is running. However, this excess fuel starting quantity is re-established during each fresh starting operation, so that excessive fuel is delivered when the engine is hot and the exhaust gases contain too high a proportion of unburnt constituents.

Increasingly lower limiting values for the proportion of injurious substances in exhaust gases are prescribed from year to year by the legal regulations relating to the pollution of the air, and, in order to meet these requirements, governors for fuel-injection internal combustion engines have to be provided with devices which reduce the excess fuel starting quantity in dependence upon the operating temperature of the engine. Devices of this kind are already known which allow the fuel delivery quantity adjusting member of the injection pump to cover an excess amount of starting travel and then reduce the amount of this excess travel in dependence upon the temperature of an operating medium or the ambient air. However, these devices have the disadvantage that the excess fuel starting quantity established also takes effect when the engine is running, particularly when the engine is operating under load in a very low range of speed.

An object of the present invention is to provide a centrifugal speed governor of the initially mentioned type with a device for obtaining a temperature-dependent controlled excess fuel starting quantity such that the excess fuel starting quantity is not established, or is only partially established, when the engine is hot, the established excess fuel starting quantity never coming into effect when the engine is running.

According to the present invention there is provided a centrifugal speed governor for controlling a fuel injection internal combustion engine, comprising a regulating member which is displaceable by fly weights in dependence upon the rotational speed of a drive shaft, the drive shaft, in use, rotating at a speed corres-

ponding to the engine speed, the movements of the regulating member being transmitted by way of an intermediate member to a fuel delivery quantity adjusting member which can be connected to and can adjust the fuel delivery quantity of a fuel injection pump, the travel of the fuel delivery quantity adjusting member in the direction of an increasing fuel delivery quantity being limited by a stop which is arranged to, in use, determine the maximum fuel delivery quantity and to rotate in dependence upon engine speed, the stop being mounted on a fixed position spindle and coupled to the regulating member, a first cam plate being provided on the spindle, this first cam plate having a cam portion arranged to determine the full load fuel delivery quantity and a further cam portion arranged to determine the excess fuel starting quantity, a follower member connected to the fuel delivery quantity adjusting member being arranged to engage said first cam plate during delivery of the maximum fuel delivery quantity for each rotational speed of said drive shaft, a second cam plate being arranged on said spindle parallel to said first cam plate, to co-operate with the follower member, this second cam plate being rotatable independently of the first cam plate by a control device operable in dependence upon the temperature of a medium, fluid or otherwise, and being arranged such that at a temperature of the medium corresponding to the engine running hot, a protuberance of the second cam plate renders inoperative said further cam portion of said first cam plate and, at temperature below the said temperature of the medium, at least partially releases the excess fuel starting quantity.

In an advantageous development of the present invention, the control device has a housing open towards the interior of the governor, and a spiral bimetal spring, one end of which spring is secured to an adjusting spindle and the other end of which acts upon the second cam plate. The air or the lubricating oil within the governor acts as the temperature-dependent operating medium. Alternatively, an electrically heated bimetal spring may be used.

In a further advantageous development of the present invention, the control device has a housing which is sealed relative to the interior of the governor and the atmosphere, and an adjusting spindle which is mounted in the housing and which is secured to one end of the spiral bimetal spring whose other end is supported on a rotatable adjusting member which is also mounted in the housing of the control device, the operating medium being the cooling water or lubricating oil of the engine, this being feedable to and dischargeable from the sealed housing by way of connection ports. In a further development of the present invention, the operating medium comprises a medium which, for example, is an electrically heated filling liquid.

The control device operating in dependence upon temperature can be fitted to the governor in a simple manner by making the housing of the control device a part of the cover of the governor.

The present invention will now be further described, by way of example, with reference to the accompanying drawings, in which:—

Fig. 1 is a longitudinal sectional view through a first embodiment of the present invention, taken on the line I-I of Fig. 2,

Fig. 2 is a cross sectional view taken on the line II-II of Fig. 1,

Fig. 3 is a longitudinal sectional view taken on the line III-III of Fig. 2,

Fig. 4 is a fragmentary cross sectional view taken on the line IV-IV of Fig. 2;

Fig. 5 is a cross sectional view, corresponding to Fig. 4, through a second embodiment of the present invention; and

Fig. 6 is a perspective view of the more important parts of the governor of the present invention, illustrating the co-operation between these parts.

A centrifugal governor 11 is secured to the drive shaft 10 (see Fig. 1) of an injection pump (otherwise not illustrated) of an internal combustion engine. The governor has pivotally mounted fly-weights 12 which have arms 13, the arms 13 being arranged to act upon the end face 14 of a thrust bearing 16. The thrust bearing 15 is mounted on an extension of a governor sleeve 16 acting as a regulating member, and transmits the adjusting forces of the fly-weights 12 to the governor sleeve 16. One end 16*a* of the governor sleeve 16 is mounted on a cylindrical end 17 of the drive shaft 10 and its other end 16*b* remote from the drive shaft 10, is provided with laterally projecting guide studs 18 which are guided in respective guide-ways 19 formed in a power transmission lever 21 (see also Fig. 3).

The power transmission lever 21 has a box-shaped, substantially U- or H-shaped cross section whose two limbs 22 directed towards the injection pump incorporate the guideways 19 for the guide studs 18 of the governor sleeve 16. An adjusting member 23 is screwed into the power transmission lever 21 coaxially of the drive shaft 10 and the governor sleeve 16, and is secured in position by means of a nut 24. The adjusting member 23 has a planar surface 26 against which a convex end face 27 of the governor sleeve 16

abuts after covering a first partial amount "*a*" of travel.

When covering the above-mentioned first partial amount *a* of travel, the governor sleeve 16 acts against a leaf spring 28 which acts as a starting or idling governing spring and whose initial stressing force, acting upon the guide studs 18 of the governor sleeve 16, is adjusted by means of a setscrew 29 which is screwed into the power transmission lever 21 and which is secured in its adjusted position.

The power transmission lever 21 is a straight two-arm lever which has a bearing pin 31 acting as a fixed pivot and whose illustrated, vertical normal position is determined by a stop 32 which is fixed relative to the housing and which is formed by the end face of a self-locking stop screw 34 screwed into the governor housing 33.

The power transmission lever 21 is pivotable in anticlockwise direction (Fig. 1) about the bearing pin 31. This pivoting movement takes place when the force occasioned by the fly-weights 12, and transmitted from the governor sleeve 16 to the power transmission lever 21 by way of the adjusting member 23, is greater than the restoring force exerted by a governing spring 35. The governing spring 35 is a tension spring which is arranged with its longitudinal axis substantially at right angles to the axis of the regulating member 16 in the governor. The spring 35 is attached to two supports 36, 37, the first support 36 being fixed relative to the housing and the second support 37 being disposed on a bell-crank lever 38 which is adjustable for setting the maximum rotational speed and which is connected to the power transmission lever 21 by way of a bearing pin 39 passing through the two limbs 22 of the power transmission lever 21. The illustrated fitted position of the bell-crank lever 38 is determined by a setscrew 41 by means of which the initial stress of the governing spring 35 is variable, thus determining the maximum rotational speed of the governor in an advantageous manner.

The governor sleeve 16 acting against the restoring forces of the governing springs 28 and 35 transmits its regulating movement to a regulating rod 45, acting as a delivery quantity adjusting member of the injection pump, by way of a guide lever 42, a slotted lever 43 acting as an intermediate lever, and an energy-storing device 44 (Figs. 2 and 3).

The guide lever 42, which is in the form of a U-shaped guide bow (see Fig. 2), is connected to the governor sleeve 16 by means of a ball-and-socket joint 46 (see also Fig. 1). The guide lever 42 is pivotally mounted in the governor housing 33 by means of two pivots 47 (see Fig. 2) and has on one limb 42*a* a first drag member 49 which is provided with a return spring 48 and whose function will be described below, the other limb 42*b* of the guide lever 42 having a second drag member 52 which connects the governor sleeve 16 to the slotted lever 43 and which is provided with a return spring 51. The extremity of the second drag member 52 has a pin 53 to which the slotted lever 43 is hinged.

The slotted lever 43 has a slotted guide 54 (Figs. 2 and 3) into which engages a guide stud 55 of a guide lever 56 which is rigidly connected to a shaft 57 journalled in the governor housing 33. The shaft 57, and thus the guide lever 56, are pivotable by means of an operating lever 58 (Fig. 2) secured to the shaft 57 outside the governor housing 33, the leverage of the two-arm slotted lever 43 varying with the position of the regulating rod 45 in a known manner. The slotted lever 43 and the energy-storing device 44 are interconnected by means of a connection bolt 59.

The end of the regulating rod 45 nearest the governor is secured to a connecting bar 61 to which the energy-storing device 44, and thus the slotted lever 43, are hinged by way of a bolt 62 (Fig. 3). In addition to being hinged to the slotted lever 43 actuable by the governor sleeve 16, the connecting bar 61 of the regulating rod 45 is also hinged to a free-swinging co-guided stop lever 63 whose pivot 64 is secured to a lever arm 65 of a control lever 67 pivotally mounted on two bearing pins 66 (Fig. 2) in the governor housing 33. One end 63*a* of the stop lever 63 carries a follower member 68 which, for limiting the maximum delivery quantity associated with each rotational speed, engages a cam plate 69 of a stop 70 or co-operates with the cam plate 69. The other end 63*b* (see also Fig. 6) of the stop lever 63 has a slot 63*c* engaged by a bolt 71 which is secured to the connecting bar 61 and which moves the stop lever 63 during movement of the regulating rod 45.

The stop 70 has a substantially sleeve-like configuration and is mounted on the lever shaft 57 and is rotatable in dependence upon the engine speed. The speed-dependent rotation of the stop 70 is controlled by the governor sleeve 16 in that the travel of the sleeve is transmitted through the ball-and-socket joint 46 to the guide lever 42 and from the limb 42*a* of the guide lever 42 to a driver 72 on the stop 70 by way of the drag member 49.

The drag member 49 (see Figs. 2 and 6) has a drag lever 73 which engages the driver 72 of the stop 70 by way of a bolt 74, and yields resiliently against the force

of the return spring 48 only in the direction in which the guide lever 42 moves with increasing rotational speed. The return spring 48 seeks to retain the drag member 49 in its normal position determined by means of a travel-limiting device formed substantially by a setscrew 75 secured in position in the drag lever 73. The setscrew 75 permits the setting or correction of the rotary position of the stop 70 or of the cam plate 69 which is associated with a specific position of the governor sleeve 16.

In addition to the rotatable stop 70 of the cam plate 69, a second cam plate 77 is arranged adjacent to or parallel to the cam plate 69 on the lever shaft 57 acting as a spindle fixed relative to the housing. Like the first cam plate 69, the second cam plate 77 cooperates with the follower member 68 of the stop lever 63 (see particularly Fig. 6) and is rotatable independently of the first cam plate 69 by a control device 78 (see also Fig. 4) operating in dependence upon the temperature prevailing in the interior of the governor housing 33, that is the temperature prevailing in the interior 76 of the governor. The second cam plate 77 has a stepped protuberance 79 which, it will be appreciated, may alternatively be provided with a sloping curve without steps. The purpose of the stepped protuberance 79 of the cam (see Figs. 3 and 6) is to render inoperative a cam portion 81 of the first cam plate 69, which determines the excess starting quantity, at a temperature of the operating medium in the interior 76 of the governor associated with the hot-running engine, and to at least partially release the excess starting quantity at temperatures below the said temperature. Here also, electrical heating of a bimetal spring may also act as the operating means. The rotary movement of the second cam plate 77 which is required for this purpose is effected within the control device 78 (see particularly Fig. 4) by means of a spiral bimetal spring 82, one end 82*a* of which is secured in a slot 83 in the adjusting spindle 84 and the other end 82*b* of which is connected to a pin 86 which engages in a recess 87 in the second cam plate 77, a lever 85 being interposed between the spring and said recess. The control device 78 has a housing 88 which is open towards the interior 80 of the governor and which, in the present embodiment, is a part of a governor cover 89. The adjusting spindle 84 is mounted in the housing 88 and its rotary position is fixed by a lock nut 90. A second cover 91 closes the governor housing 33 from the top.

As may be clearly seen from the perspective view shown in Fig. 6, the first cam plate 69 has a portion 92 serving as the region for determining the full load fuel delivery quantity, and the portion 81 determining the excess fuel starting quantity. The steplike transition between the two portions 92 and 81 is formed by a shoulder 93 which, when starting a cold engine, acts as a starting locking device when the follower member 68 of the stop lever 63 pivots past the shoulder 93 and is located (not shown) in the region of the cam portion 81. However, Fig. 6 shows the second cam plate 77 in the position which it assumes when the engine is operating under hot running conditions and, when the cam plate 77 is in this position, the follower member 68 of the stop lever 63 can pivot only into its position 68′ shown by dash-dot lines. When the engine is cold, the second cam plate 77 is turned in anti-clockwise direction (Fig. 6) by corresponding pivoting such that it does not prevent the stop lever 63 from pivoting up to the portion 81 of the first cam plate 69. When the stop lever 63 is in this pivoted position (not shown), the excess fuel starting quantity is maintained until the governor has attained its governing speed and the slotted lever 43 moves the regulating rod 45 in the direction of arrow D in Fig. 3. Since the governor sleeve 16 seeks to further rotate the stop 70 with the first cam plate 69 during this regulating operation, the drag member 49 comes into operation and permits further movement of the governor sleeve 16 and the guide lever 42 despite the stationary stop 70. The driver 72 and the bolt 74 of the drag lever 73 are thus also stationary, and the return spring 48 is prestressed.

However, as soon as the governor withdraws the regulating rod 45 in the "stop" direction (arrow D) below the position corresponding to the full load fuel delivery quantity, the follower member 68 of the stop lever 53 moving away from the portion 81 of the cam plate 69 and sliding along the shoulder 93 at least into the position 68′ (Fig. 6) shown by dash-dot lines, the drag member 49 is relieved of tension and moves the stop 70 and thus the cam plate 69 into, for example, its second position 69′ indicated by dash-dot lines. When in this position, the follower member 68, 68′ co-operates with the portion 92 of the cam plate 69 and determines the full load fuel delivery quantity.

The initial stressing force of the first drag member 49 is so great that the frictional force acting on the cam plate 69, that is the force produced by the contact force of the follower member 68, is overcome predominantly in the region of the portion 92 of the cam plate 69. However,

this initial stressing force must not be so great that the desired starting locking action on the shoulder 93 of the cam plate 69 is maintained for an inadmissably long period of time.

The return spring 51 of the second drag member 52 must have an initial stressing force which is several times greater than that of the return spring 48 of the drag member 49, since the second drag member 52 acts in the same direction as the first drag member 49 and a return spring 51 which is too soft might lead to the yielding of the second drag member 52 in the case of a sluggish regulating rod 45. This is inadmissible for reasons of safety, since it is essential to ensure the shut-off movement of the governor. During other operating conditions, for example when the operating lever and thus the interior parts of the governor are already in their stop positions due to the engine brake, and the governor seeks to govern when, for example, the vehicle is driving the engine, the second drag member 52 permits a regulating movement of the regulating member 16 and of the guide lever 42 by the prestressing of the return spring 51. This feature avoids over-stressing of the interior parts of the governor.

The drag lever 73 of the first drag member 49, and a drag lever 95 of the second drag member 52, are each mounted on a respective one of the two pivots 47 of the guide lever 42 and their return springs 48 and 51, which are in the form of helical springs, abut at one end against the limbs 42*a* and 42*b* of the guide lever 42 and at the other end against the drag levers 73 and 95.

To ensure that the governor functions in the above-described manner under all operating conditions, the energy-storing device 44 disposed between the regulating rod 45 and the slotted lever 43 acts as a third resilient drag member together with the two drag members 49 and 52. A return spring is designated 96 and has an initial stressing force which is greater than the resistance of the regulating rod 45 to movement and which is at the same time sufficiently small to avoid obstruction of the rotary movement of the cam plate 69 during increasing rotational speed outside the starting range.

The pivoted position of the control lever 67 determines the position of the pivot 64 of the stop lever 63 and thus the position of the regulating rod 45 which is associated with the cam plate 69 of the stop 70. This pivoted position of the control lever 67 is determined in the direction of an increasing fuel delivery quantity by a stop screw 97 which is adjustable externally and which is provided with a head 97*a*, and a bolt 94 secured to the control lever 67 is urged against the head 97*a* by a play-compensating spring 98 in order to retain the control lever 67 in this position.

The second embodiment differs from the first embodiment illustrated in Figs. 1 to 4 and 6 only in that the control device 100 shown in Fig. 5 is modified relative to the control device 78. The control device 100 is accommodated in a housing 101 which forms part of a governor cover designated 102 and which is sealed towards the interior 76 of the governor and towards the outside. One end 104*a* of a spiral bimetal spring 104 is secured to an adjusting spindle 103 mounted in the housing 101, the other end 104*b* of the spring 104 being supported on a rotatable adjusting member 105 which is also mounted in the housing 101 of the control device 100. The control device 100 which, like the control device 78, operates in dependence upon a temperature of an operating medium, uses the cooling water or the lubricating oil of the engine as an operating medium which is fed to and discharged from the sealed portion 101*a* of the housing 101 by way of two connection sockets 106 (only one of which is visible in Fig. 5). The adjusting spindle 103 extends outside the sealed portion 101*a* of the housing 101 and has an adjusting lever 107 connected thereto, which lever 107 is accommodated in a housing portion 101*b* open towards the interior of the governor, and is attached to the second cam plate 77 eccentrically of the axis of rotation thereof. Alternatively, the sealed portion 101*a* of the housing 101 may contain an operating medium in the form of a non-flowing medium such as an electrically heated filling fluid.

The perspective view in Fig. 6 shows the interaction of the most important parts of the governor which co-operate with the cam plate 69 of the stop 70 and with the cam plate 77 of the control device 78. For the sake of clarity, the slotted lever 43 coupled to the connecting bar 61 and to the regulating rod, together with the associated connection members of the slotted lever 43, and the second drag member 52 connected to the limb 42b of the guide lever 42, have been omitted. Fig. 6 serves primarily to clarify the following description of the mode of operation of the governor in accordance with the invention. The adjusting spindle 84, the bimetal spring 82 and the lever 85 are the only parts of the control device 78 which are shown. Analogously, this Figure can also apply to the second embodiment shown in Fig. 5, since the lever 85, the spindle 84 and the bimetal spring 82 would only

have to be replaced by the corresponding parts of the control device 100.

The first embodiment of the governor constructed in accordance with the invention, and illustrated in Figs. 1 to 4 and 6, is a so-called variable speed governor or universal speed governor and operates in the following manner:

The moving parts of the regulator are shown in their normal positions, the operating lever 58 and thus the guide lever 56 and all of the other parts from the fly-weight 12 to the regulating rod 45 being in their stop positions.

During starting of the internal combustion engine, the operating lever 58 and thus the guide lever 56 (see Figs. 2 and 3) are pivoted in the direction of the arrow B into the full load position or, to be more precise, into the position for the maximum rotational speed to be regulated, the slotted lever 43 thus displacing the regulating rod 45 in the direction of the arrow C into the starting position by way of the energy-storing device 4. The connecting bar 61 thus moves the stop lever 63 by way of the bolt 71 (see Figs. 2 and 6), the follower member 68 of the stop lever 63 moving from the position illustrated in Figs. 1, 3 and 6 when the engine is hot into the position 68′ (shown in dash-dot lines in Fig. 6) in which it abuts against the outer boundary of the cam plate 77. When the engine is cold, the cam plate 77 is located beyond the range of contact of the stop lever 63 or the follower member 68 of the stop lever 63, and the follower member 68 then pivots in the same operating position past the shoulder 93 of the cam plate 69 into the region of the cam portion 81. The follower member 68 can also be arrested shortly beforehand if the travel of the regulating rod 45 is limited by other known stops (not shown). When the regulating rod 45 is in this starting position, the injection pump feeds to the internal combustion engine a quantity of fuel which exceeds the full load quantity of fuel and facilitates starting of the engine.

Since the cam plate 77 has a stepped protuberance 79, the reducing of the excess starting quantity by the control device 78 is effected in stages when the engine is warming up and, according to the temperature of the operating medium attained, the full load quantity of fuel, the maximum excess starting quantity or a quantity between these two quantities is established for the purpose of starting. In the embodiment illustrated in Figs. 1 to 4 and 6 and having the control device 78, the adjusting spindle 84 is fixedly screwed in the housing, and the bimetal spring 82 actuates the lever 85 in a clockwise direction in Fig. 6 when the temperature of the operating medium is increasing, so that the cam plate 77 is pivoted in an anti-clockwise direction and, according to the increase in temperature, the protuberance 79 moves to a greater or lesser extent outside the pivoting range of the follower member 68. A basic setting can be effected by turning the adjusting spindle 84 in the housing 88. After the setting operation, the lock nut 90 is tightened to an extent where the adjusting spindle 84 can no longer turn. The above-described operation during starting, and the turning of the second cam plate 77 during warming-up of the engine, can also be seen from Fig. 3, it having to be borne in mind that the stated directions of rotation are reversed owing to the different direction of view.

When the motor has started and the operating lever 58 is maintained in, for example, the full load position, the engine speed continues to increase and the fly-weights 12 pivot outwardly from their illustrated inner position, under the action of the centrifugal forces. The arms 13 of the fly-weights 12 then press against the governor sleeve 16 by way of the thrust bearing 15 in a known manner, and the governor sleeve 16 is displaced against the force of the leaf spring 28 (see Fig. 1) until the end face 27 of the governor sleeve abuts against the planar surface 26 of the adjusting member 23 screwed into the power transmission lever 21. During this movement of the sleeve 16 by the partial amount a of travel, which is covered during the first seconds of the starting operation, the governor sleeve 16 moves the ball-and-socket joint 46 by the same amount and seeks to move the regulating rod 45 in the direction of arrow D from the starting position to the full load position or therebeyond into the stop position by way of the transmission members 42, 43 and 44 hinged thereto.

During this movement of the sleeve 16, the first drag member 49 (see Figs. 2 and 6), also connected to the guide lever 42, seeks to turn the stop 70 in a clockwise direction. During cold-starting of the engine, during which the second cam plate 77 is not located in the pivoting range of the follower member 68, the shoulder 93 on the cam plate 69 prevents the stop 70 from turning until the follower member 68 has assumed its position 68′ shown by dash-dot lines in Fig. 6. This position is reached only when the set rotational speed pre-selected by the operating lever 58 is attained or is slightly exceeded. The governor sleeve 16 has then moved beyond the partial amount a of travel by the partial amount b, the power transmission

lever 21 having turned in an anti-clockwise direction under the increasing force of the sleeve and having been raised from its stop 32. As soon as the follower member 68 has assumed its position 68′ shown by dash-dot lines in Fig. 6, the cam plate 69 can continue to turn into its rotary position designated 69′. The drag member 49 has been initially stressed in the manner already described above until the full load speed has been attained or slightly exceeded. When the second cam plate 77 is in its position shown in Figs. 3 and 6, when the engine is running hot, the follower member, during the starting operation, cannot move beyond its position 68′ shown by dash-dot lines, and the drag member 49 also does not have to be initially stressed.

During full load operation, the prevailing rotary position of the stop 70 or the cam plate 69 changes corresponding to the associated position of the sleeve, and the cam portion 92, against which the follower member 68 abuts, determines the position of the regulating rod 45 which is associated with each rotational speed, and thus the associated maximum quantity of fuel. In a manner known per se, any optional fuel delivery quantity characteristic (adaption characteristic) can be realised by appropriate configuration of the cam portion 92.

When the maximum set rotational speed is exceeded when the motor is operating under part load, which corresponds to an amount of travel of the sleeve in excess of $a + b$, the power transmission lever 21 continues to move in an anti-clockwise direction, and the governor sleeve 16 brings the transmission members 42, 43, 44 and the regulating rod 45 into a position in which the quantity of fuel from the injection pump is decreased until it corresponds to the power taken by the engine, and the engine speed is maintained within the P range, or until the supply of fuel is entirely cut off.

The second drag member 52 is disposed in the connection between the guide lever 42 and the slotted lever 43 in order to compensate for the difference between the distances travelled by the regulating rod 45 in the direction of the respective arrows D and C, this difference occurring during control of the adaptation and being caused by the protuberance 92 on the cam plate 69.

The mode of operation of the second embodiment is identical to that of the first embodiment with respect to the function of the governor. Owing to the modified construction of the control device 100 relative to the control device 78 of the first embodiment, the second cam plate 77 is actuated by the control device 100 in a somewhat different manner. During a variation in the temperature of the operating medium, whether it be the temperature of the cooling water or the temperature of the lubricating oil conducted through the chamber 101*a*, the bimetal spring 104 turns in such a manner that the adjusting spindle 103, and thus the adjusting lever 107, are turned. Since the end 104*b* of the bimetal spring is rigidly secured to the adjusting member 105, the basic setting of the control device 100 can be effected by turning the adjusting spindle 105 in the housing 101.

WHAT WE CLAIM IS:—

1. A centrifugal speed governor for controlling a fuel injection internal combustion engine, comprising a regulating member which is displaceable by fly weights in dependence upon the rotational speed of a drive shaft, the drive shaft, in use, rotating at a speed corresponding to the engine speed, the movements of the regulating member being transmitted by way of an intermediate member to a fuel delivery quantity adjusting member which can be connected to and can adjust the fuel delivery quantity adjusting member in the direction of an increasing fuel delivery quantity being limited by a stop which is arranged to, in use, determine the maximum fuel delivery quantity and to rotate in dependence upon engine speed, the stop being mounted on a fixed position spindle and coupled to the regulating member, a first cam plate being provided on the spindle, this first cam plate having a cam portion arranged to determine the full load fuel delivery quantity and a further cam portion arranged to determine the excess fuel starting quantity, a follower member connected to the fuel delivery quantity adjusting member being arranged to engage said first cam plate during delivery of the maximum fuel delivery quantity for each rotational speed of said drive shaft, a second cam plate being arranged on said spindle parallel to said first cam plate, to co-operate with the follower member, this second cam plate being rotatable independently of the first cam plate by a control device operable in dependence upon the temperature of a medium, fluid or otherwise, and being arranged such that at a temperature of the medium corresponding to the engine running hot, a protuberance of the second cam plate renders inoperative said further cam portions of said first cam plate and, at temperatures below the said temperature of the medium, at least partially releases the excess fuel starting quantity.

2. A centrifugal speed governor as claimed in Claim 1, in which the control device has a housing open towards the interior of the governor, and a spiral bimetal spring, one end of which spring is secured to an adjusting spindle and the other end of which acts upon the second cam plate.

3. A centrifugal speed governor as claimed in Claim 1, in which the control device has a housing which is sealed relative to the interior of the governor and the atmosphere, and an adjusting spindle which is mounted in the housing and which is secured to one end of a spiral bimetal spring whose other end is supported on a rotatable adjusting member which is also mounted in the housing of the control device.

4. A centrifugal speed governor as claimed in Claim 3, in which the operating medium is the cooling water or lubricating oil of the engine and is feedable to and dischargeable from the housing by way of connection sockets in a sealed portion of the housing.

5. A centrifugal speed governor as claimed in Claim 3, in which the operating medium is an electrically heated liquid.

6. A centrifugal speed governor as claimed in any one of the Claims 3, 4 or 5, in which the adjusting spindle has an adjusting lever which is located outside the sealed portion of the housing in a housing portion open towards the interior of the governor and which acts upon the second cam plate eccentrically of the axis of rotation thereof.

7. A centrifugal speed governor as claimed in any one of the Claims 2 to 6, in which the housing of the control device forms part of the governor cover.

8. A centrifugal speed governor for controlling a fuel injection internal combustion engine, constructed and arranged substantially as hereinbefore described with reference to and illustrated in the accompanying drawings.

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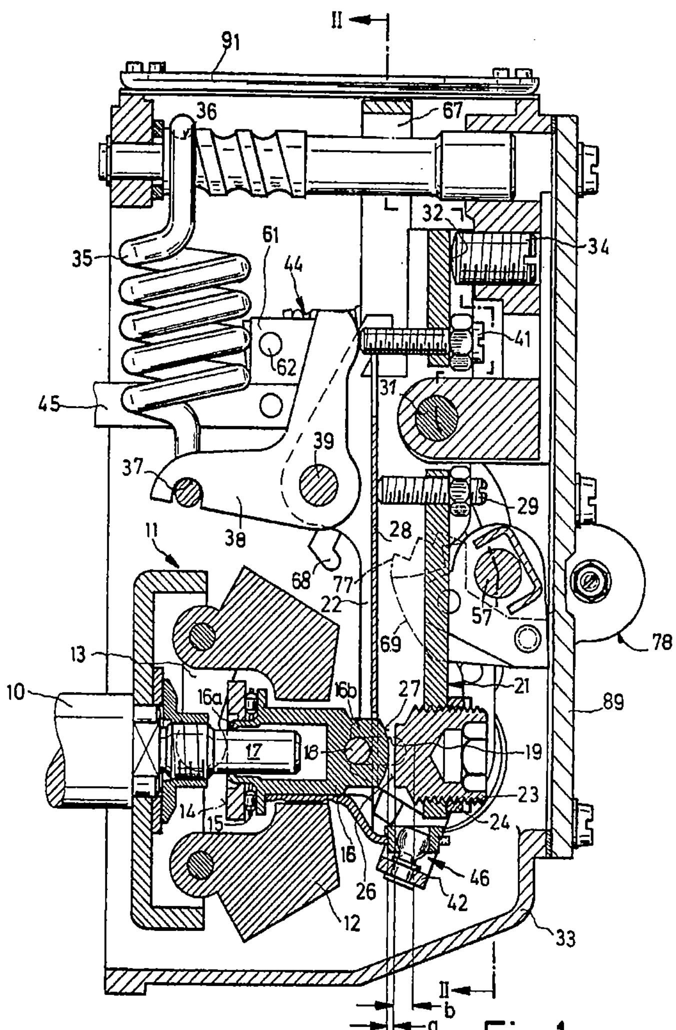
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Fig. 1

1451059 COMPLETE SPECIFICATION

5 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

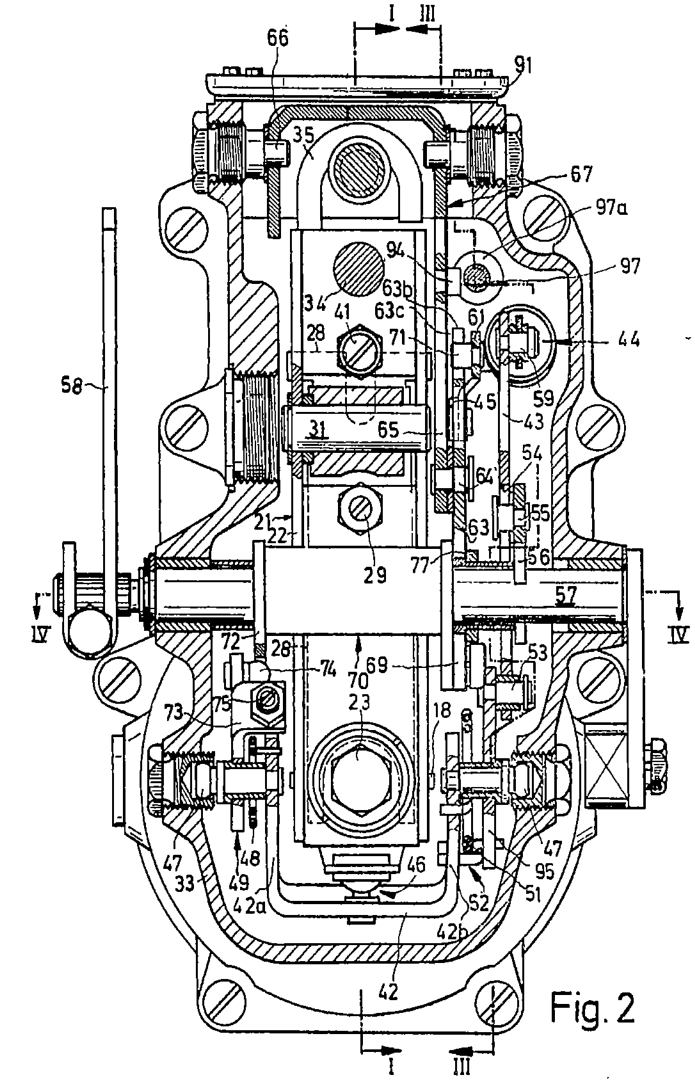


Fig. 2

1451059 COMPLETE SPECIFICATION

5 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 3

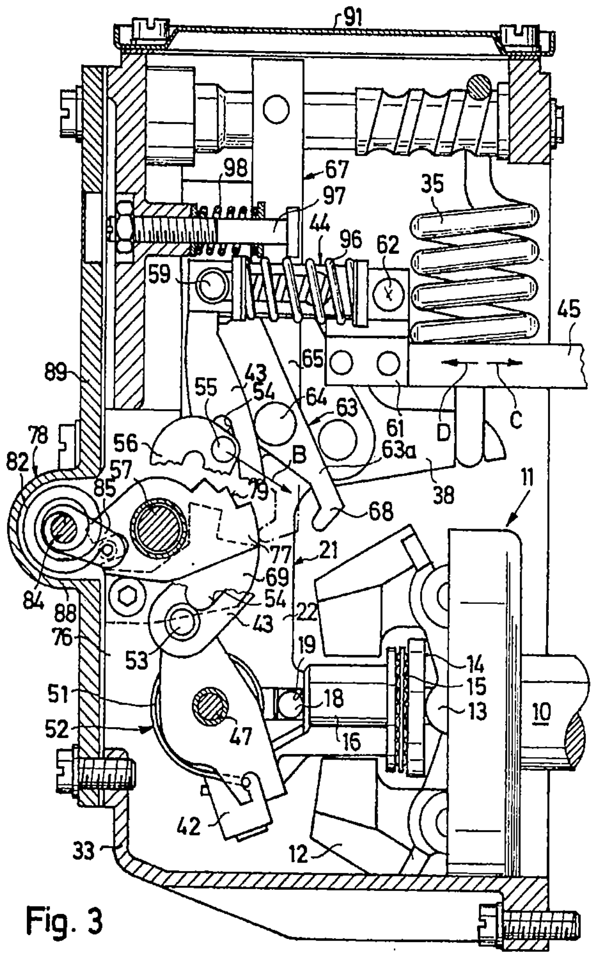
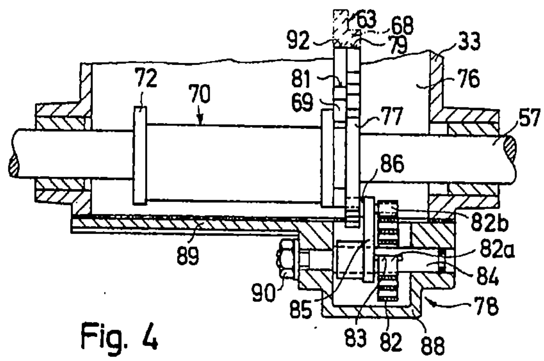


Fig. 3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33
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82a
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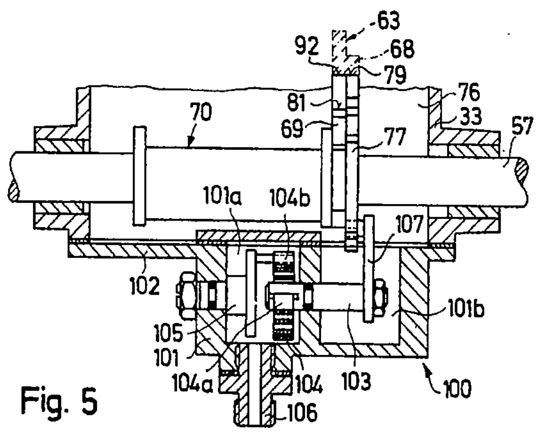
82
88

Fig. 4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104a
104
103
100
106

Fig. 5

1451059 COMPLETE SPECIFICATION

5 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 5

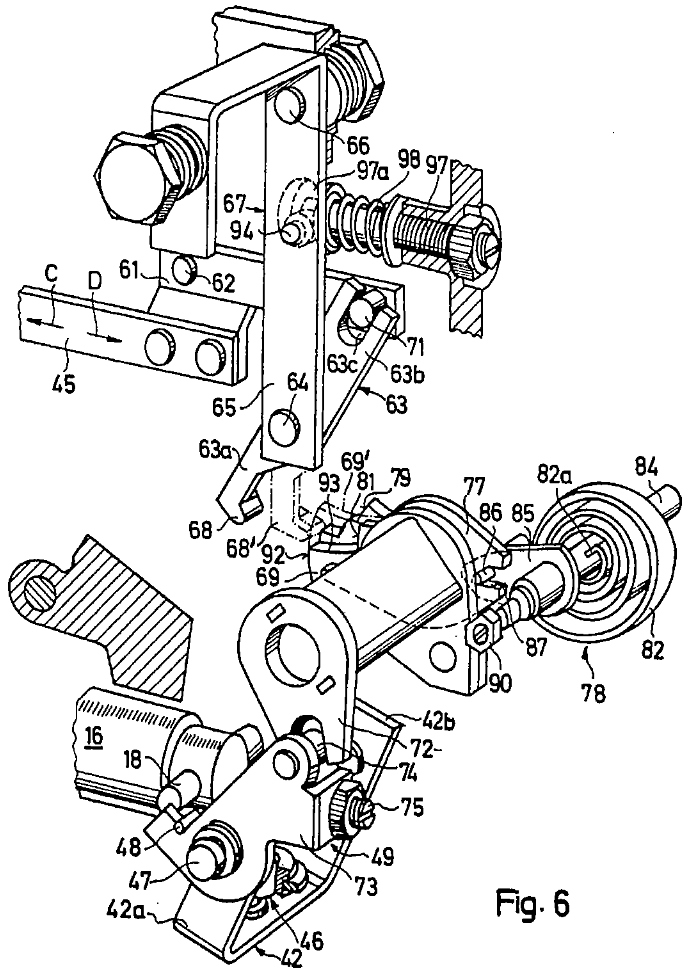

Fig. 6